

Endovascular Treatment of Paraclinoid Aneurysms: Experience with 73 Cases

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Introduction

- Aneurysms arising from the internal carotid artery in close relation to the clinoid process have been termed paraclinoid aneurysms.
- Direct surgical treatment has been associated with an unusually high morbidity and mortality because such aneurysms often pose conceptual and technical problems with regard to acquisition of proximal control and safe intracranial exposure.

Introduction

- As the use of endovascular therapy for cerebral aneurysms has grown over the last few years, paraclinoid aneurysms are frequently referred for endovascular treatment.
- We reviewed our experience with endovascular embolization of paraclinoid aneurysms using detachable platinum coils.

Patient Population

- From December 1993 to May 2002, 70 patients underwent endovascular procedures with coils for 73 paraclinoid aneurysms (8 ruptured, 65 unruptured) at the University of Pittsburgh Medical Center and the University of Texas Southwestern Medical Center.
- A retrospective review of the medical records, radiographic studies, and endovascular procedure reports was performed.

Clinical Analysis

- Initial patient clinical status was assessed using the Hunt and Hess scale.
- To assess clinical outcome the Glasgow Outcome Scale (GOS) was recorded at discharge and follow-up.
- Procedure-related morbidity was defined as a neurological deficit lasting >7days that was attributable to the coil embolization procedure.

Clinical outcome: Glasgow Outcome Scale

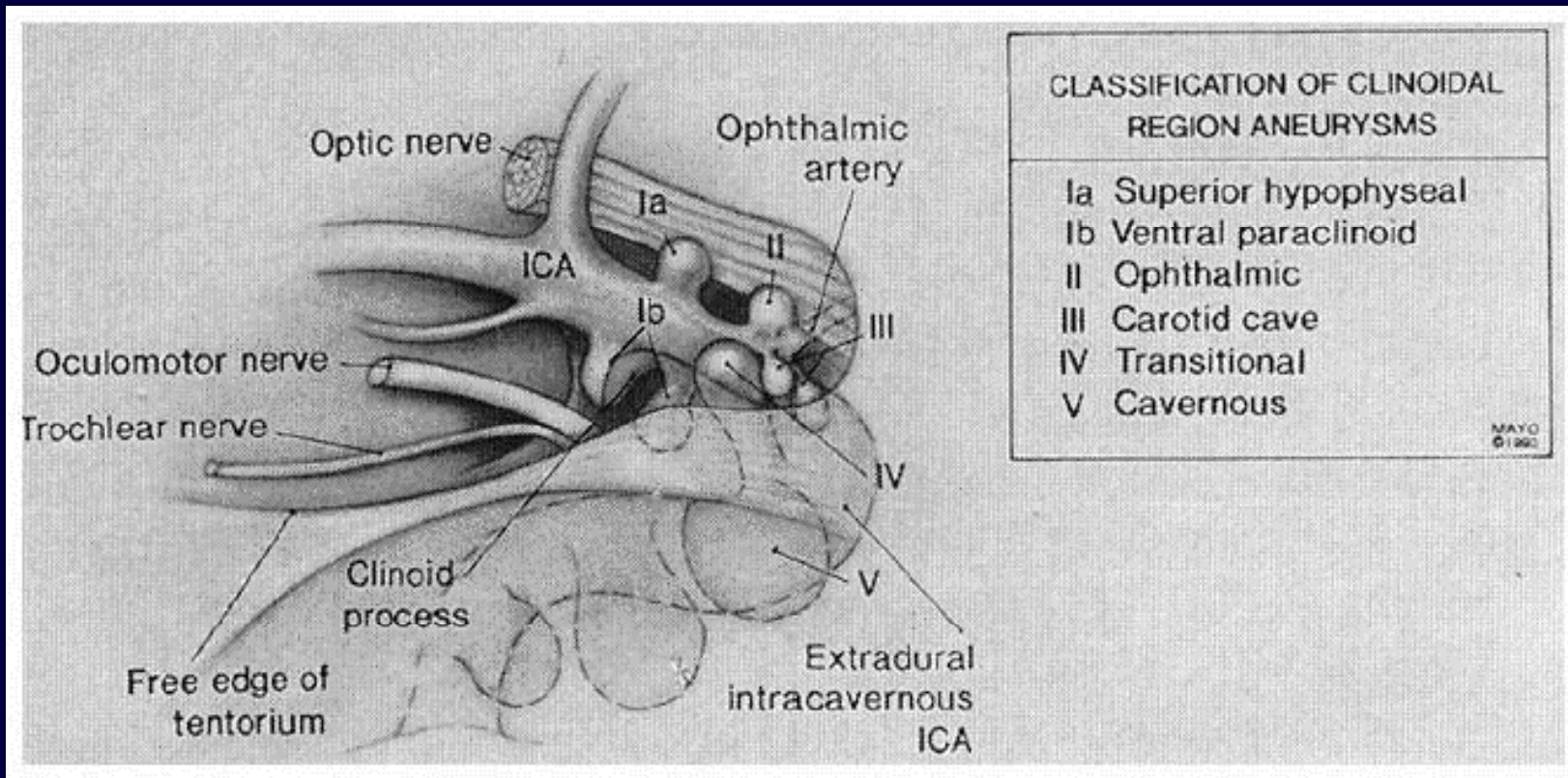
Score	Definition	Description
5	Good recovery	Resumption of normal activities even though there may be minor neurological or psychological deficits.
4	Moderate disability (Disabled but independent)	Patient is independent as far as daily life is concerned. The disabilities found include varying degrees of dysphasia, hemiparesis, or ataxia, as well as intellectual and memory deficits and personality changes.
3	Severe disability (conscious but disabled)	Patient depends upon others for daily support due to mental or physical disability or both.
2	Vegetative survival	Patient exhibits no obvious cortical function.
1	Dead	

Endovascular Technique

- General anesthesia
- Systemic heparinization
- 6F guiding catheter(Envoy), microcatheter(Rapid transit), guidewire(Glide wire)
- Coils: Micrus spherical 3D coils, Target GDCs
- Remodeling technique: angioplasty balloon(Endeavor, Solstice)

Aneurysm Subtype

- Carotid cave aneurysms
- Ophthalmic aneurysms
- Superior hypophyseal aneurysms
- Ventral paraclinoid aneurysms
- Transitional aneurysms



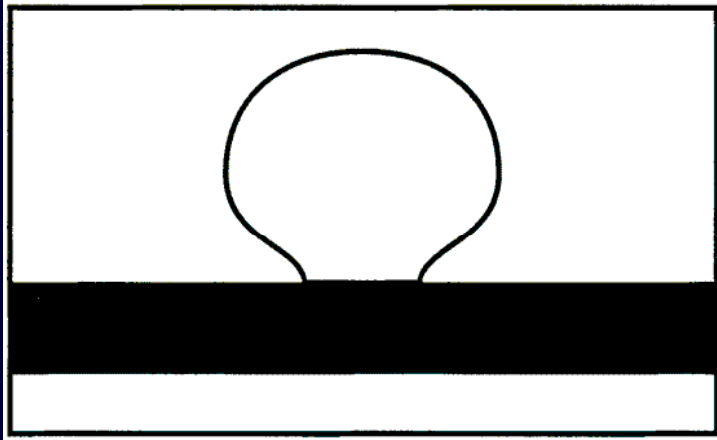
Diagrammatic representation of the proposed classification of paraclinoid aneurysms (From, Al-Rodhan NRF, Piepgras DG, Sundt TM Jr: Transitional cavernous aneurysms of the internal carotid artery. Neurosurgery 33:993-998, 1993 [3].)

Aneurysm Size

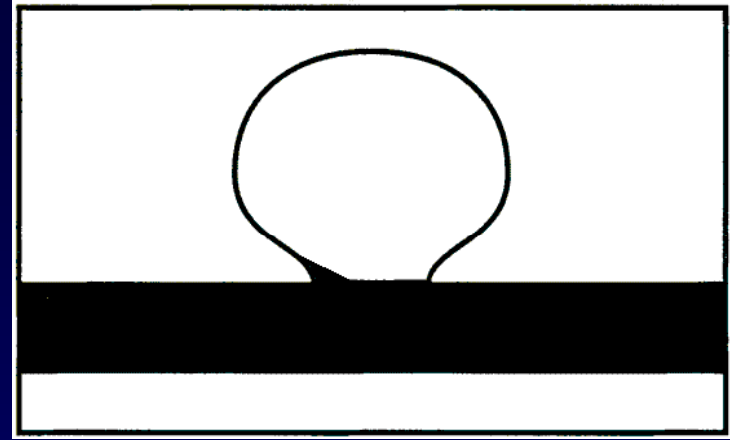
- Fundus sizes
 - small: <10 mm
 - large: 10-24 mm
 - giant: >24 mm
- Neck sizes
 - narrow: <4 mm
 - wide: >4 mm
- Fundus/neck ratios
 - favorable: >2
 - unfavorable: ≤ 2

Embolization Evaluation

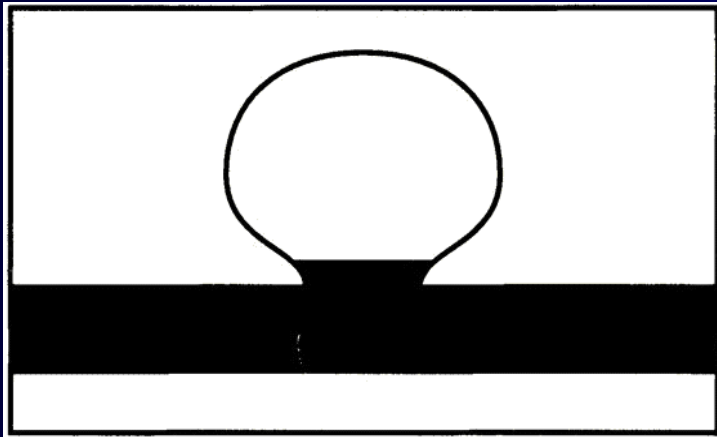
- Complete occlusion: when the sac and neck were densely packed in any projection.
- Near-complete occlusion: when the sac was occluded but there was suspicion of a neck remnant or there was an obvious small neck remnant less than 2mm.
- Partial occlusion: when there was loose packing and/or persistent opacification of the sac or neck remnant greater than 2mm.



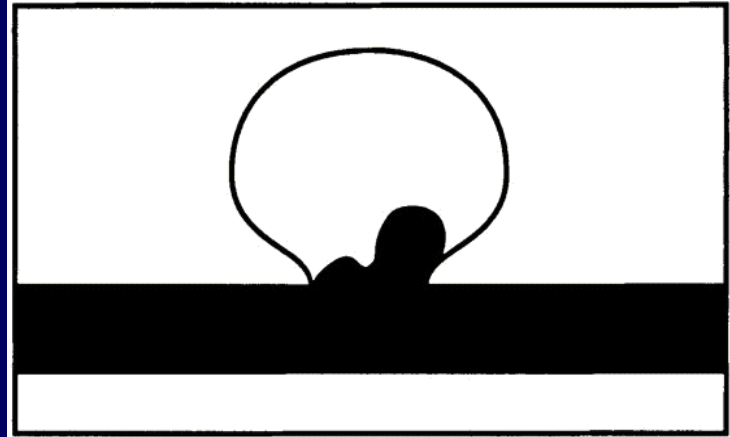
Complete



Near-complete



Partial (Residual neck)



Partial (Residual fundus)

Angiographic Follow-Up

- Follow-up angiograms were usually obtained 6 months and 1 year postembolization if complete or near-complete aneurysm occlusion was achieved.
- Patients with partial aneurysm occlusion had angiographic follow-up 3 months postembolization.
- Additional follow-up was done in patients with a potential risk of coil compaction.

Patients Characteristics

- Seventy patients with 73 paraclinoid aneurysms were evaluated.
- Nine patients (13%) were male and 61 patients (87%) were female.
- Patient ages ranged from 32 to 77 years (mean age, 53.6 years).

Clinical Presentation

Clinical presentation	No. of Patients(%) (n=70)
SAH	8 (11.4%)
H-H I	1
H-H II	2
H-H III	2
H-H IV	3
Visual symptom	5 (7.2%)
Incidental	57 (81.4%)

Aneurysm Location

Subtype of Aneurysm	No. of Aneurysms		Total (%)
	Ruptured (n=8)	Unruptured (n=65)	
Carotid cave	1	16	17 (23.3)
Ophthalmic	2	16	18 (24.7)
Superior hypophyseal	4	22	26 (35.6)
Ventral paraclinoid	1	9	10 (13.7)
Transitional	0	2	2 (2.7)

Fundus Size of Aneurysms

Fundus size	No. of Aneurysms		Total (%)
	Ruptured (n=8)	Unruptured (n=65)	
Small (≤ 10 mm)	3	47	50 (68.5)
Large (11-24 mm)	3	17	20 (27.4)
Giant (≥ 25 mm)	2	1	3 (4.1)

Fundus/Neck Ratio of Aneurysms

Fundus/Neck ratio	Small (≤ 10 mm) (n=50)	Large (11-24 mm) (n=20)	Giant (≥ 25 mm) (n=3)	Total (%)
Favorable (>2)	15	10	2	27 (37%)
Unfavorable (≤ 2)	35	10	1	46 (63%)

Cf. Aneurysm neck (1-8mm)

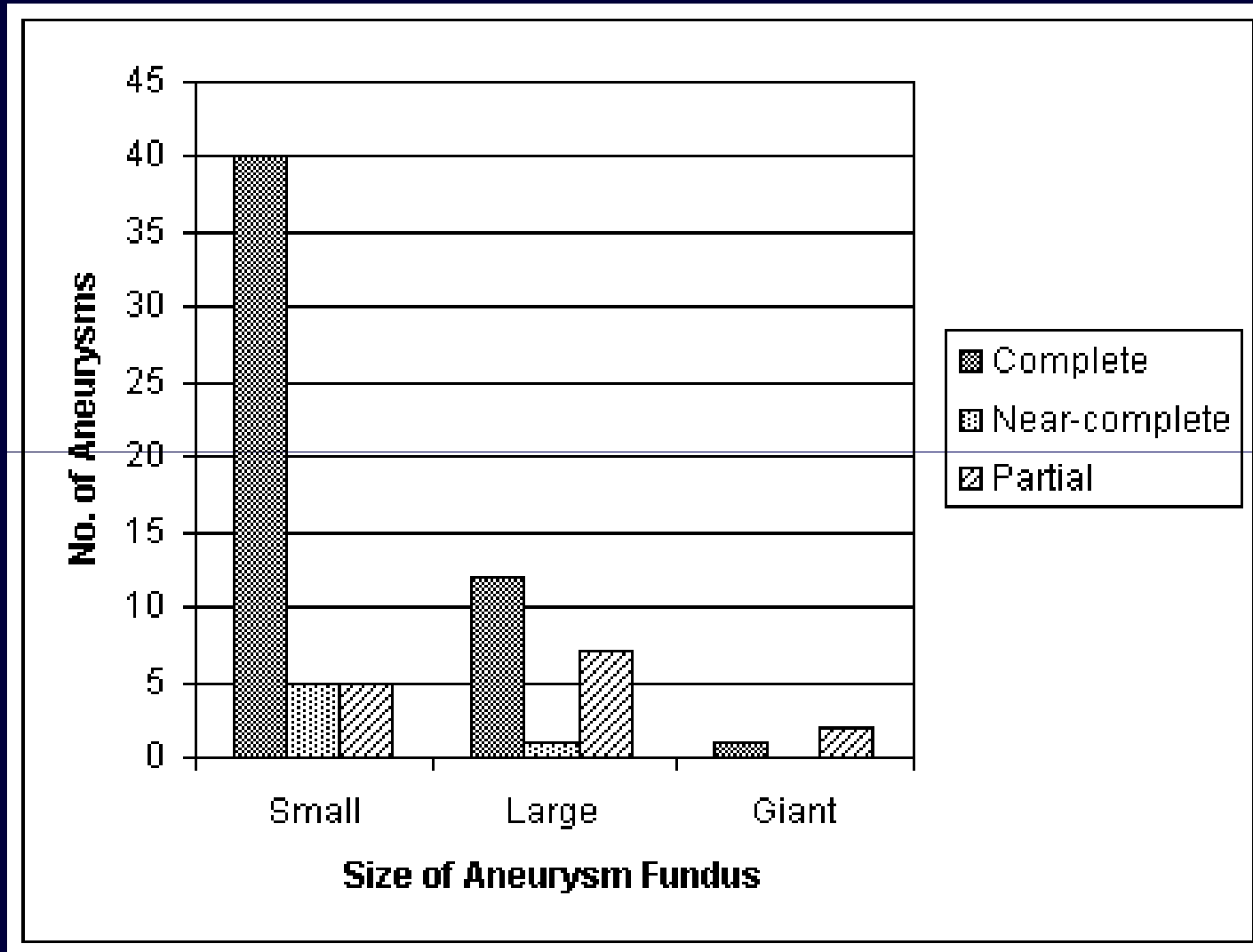
- Narrow: 49 (67.1%)
- Wide: 24 (32.9%)

Multiple Aneurysms

- Twenty four (34.3%) patients had multiple aneurysms.
- Two aneurysms were found in 18 patients each, 3 were found in 3 patients each, and 4 were found in 3 patients each.
- Nine (37.5%) of these patients had other aneurysms in a paraclinoid location.

Initial Degree of Occlusion

- Complete occlusion: 53 (72.6%) aneurysms (*40 of 50 small aneurysms, 12 of 20 large aneurysms, 1 of 3 giant aneurysms*)
- Near-complete occlusion: 6 (8.2%) aneurysms (*5 of 50 small aneurysms, 1 of 20 large aneurysms*)
- Partial occlusion: 14 (19.2%) aneurysms (*5 of 50 small aneurysms, 7 of 20 large aneurysms, 2 of 3 giant aneurysms*)



Initial degree of occlusion based on aneurysm size. The bar graph shows the number of aneurysms in each degree of occlusion immediately after embolization (n=73).

Multiple and Ancillary Endovascular Procedures

- Among 73 paraclinoid aneurysms managed with endovascular embolization, 9 (12%) required more than one session of endovascular treatment to complete treatment.
- 8 of these aneurysms required 2 sessions and 1 required 4.
- A total of 84 endovascular procedures, which included 16 procedures using the balloon remodeling technique, were done.

Follow-Up Degree of Occlusion

- Follow-up cerebral angiograms could be obtained in 49 patients (70%) with 52 paraclinoid aneurysms.
- Follow-up angiograms could not be performed due to death (3 patients), patient refusal (2 patients), old age/infirmity (3 patients), and loss to follow-up (7 patients). Six were waiting for their first follow-up angiography.

Follow-Up Degree of Occlusion

- Of these 21 patients whose follow-up angiograms were not available, the immediate postprocedural angiogram showed complete occlusion in 17 (81%) and partial occlusion in 4 (19%).
- Angiographic follow-up ranged from 4 to 54 months (mean, 13.9 months).

Follow-Up Degree of Occlusion

- During the follow-up period, 6 (42.8%) of 14 aneurysms initially demonstrating partial occlusion and 3 of 6 (50%) aneurysms initially demonstrating near-complete occlusion showed spontaneous progression to complete occlusion.
- Aneurysm recanalization attributable to coil compaction occurred in 12 aneurysms.

Follow-Up Degree of Occlusion

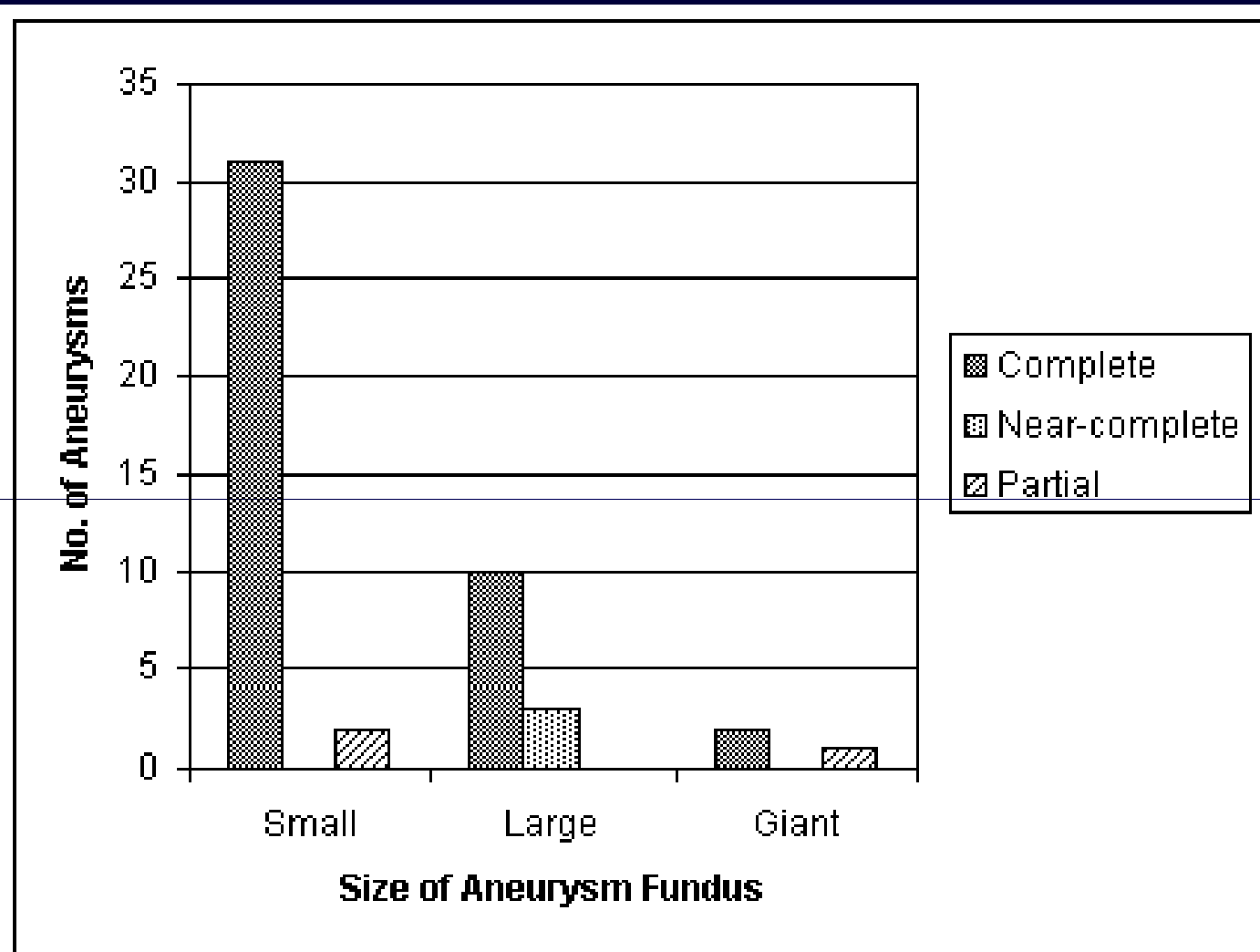
- Among these 12 recanalized aneurysms, 5 aneurysms initially demonstrated complete occlusion (9.4% of completely occluded aneurysms), 3 demonstrated near-complete occlusion (50% of near-completely occluded aneurysms), and 4 demonstrated partial occlusion (28.6% of partially occluded aneurysms)
- 3 underwent surgical clipping and the remaining 9 had repeated coiling.

Characteristics of aneurysms retreated (n=12)

Aneurysm			Initial degree of occlusion	FU degree of occlusion at the time of retreatment	Time of retreatment after initial embolization (mo)	Retreatment	Final degree of occlusion after retreatment	Length of angiographic FU after initial embolization (mo)
Subtype	Size	Fundus /neck ratio						
Superior hypophyseal	Small	≤2	Complete	Partial	2	Clipping	Complete	4
Ventral paraclinoid	Small	≤2	Complete	Partial	6	Clipping	Complete	6
Carotid cave	Small	≤2	Complete	Partial	23	Coiling	Complete	35
Carotid cave	Small	≤2	Near-complete	Partial	35	Coiling	Partial	35
Carotid cave	Small	≤2	Near-complete	Partial	4	Coiling (remodeling)	Complete	13
Ophthalmic	Small	≤2	Partial	Partial	15	Clipping	Complete	23
Ophthalmic	Large	>2	Complete	Partial	7	Coiling	Complete	7
Ophthalmic	Large	>2	Near-complete	Partial	26	Coiling	Near-complete	26
Superior hypophyseal	Large	≤2	Partial	Partial	7	Coiling	Near-complete	43
Ophthalmic	Large	≤2	Partial	Partial	7	Coiling (remodeling)	Complete	20
Superior hypophyseal	Giant	>2	Complete	Partial	1, 3, 26	Coiling	Partial	26
Ophthalmic	Giant	>2	Partial	Partial	6	Coiling	Complete	6

Follow-Up Degree of Occlusion

- The final angiographic outcomes of 49 aneurysms excluding 3 surgically clipped aneurysms
 - complete occlusion: 43 (87.8%) aneurysms (31 small, 10 large, and 2 giant)
 - near-complete occlusion: 3 (6.1%) aneurysms (All large)
 - partial occlusion: 3 (6.1%) aneurysms (2 small and 1 was giant)



Follow-up degree of occlusion based on aneurysm size. The bar graph shows the number of aneurysms in each degree of occlusion after a follow-up period of at least 4 months after initial embolization (n=49).

Procedural Complications

- There were 10 (11.9%) immediate procedural complications out of 84 procedures.
- Eight of these occurred during initial embolization and 2 during repeated embolization. One complication was associated with the remodeling technique.
- The overall morbidity lasting > 7 days was 8.3%. There was no immediate procedure related mortality.

Procedural complications and clinical outcomes in relation to location and size of aneurysm (n=10)

Complications	Aneurysm			Angiographic finding †	Specific management	Clinical outcome
	Clinical presentation	Subtype	Size			
Rupture (2/84; 2.4%)	Subarachnoid hemorrhage	Superior hypophyseal	Large	Minor leak of contrast	Deposition of coils	No sequelae
	Incidental	Superior hypophyseal	Small	Active leak of contrast	ICA occlusion+ distal clipping	Vegetative
Thrombo-embolic (6/84; 7.1%)	Incidental	Superior hypophyseal	Large	MCA distal branch occlusion	t-PA (local)	Hemiparesis
	Incidental	Ophthalmic	Small	Thrombus formation on ICA	Tirofiban (systemic)	Hemiparesis
	Recurrence	Ophthalmic	Large	P3 occlusion (Fetal PCA)		Homonymous hemianopsia Scotoma
	Incidental	Superior hypophyseal	Small	Retinal artery occlusion		No sequelae
	Incidental	Ophthalmic	Small	Ophthalmic artery occlusion		No sequelae
	Visual symptom	Ophthalmic	Large	MCA branch occlusion	Abxicimab (systemic)	No sequelae
Unexplained (2/84; 2.4%)	Recurrence	Ophthalmic	Giant	Negative		Hemiparesis
	Subarachnoid hemorrhage	Superior hypophyseal	Large	Negative		Hemiparesis

† MCA, middle cerebral artery; P3, quadrigeminal segment of posterior cerebral artery; PCA, posterior cerebral artery.

Length of Hospital Stay

- The average hospitalization period was 17.8 days in patients with acutely ruptured aneurysms, and 3.5 days in patients with unruptured and recoiled aneurysms.

Cf. Yundt et al. (J Neurosurg 85:403-409, 1996) retrospectively reviewed the clinical and hospital financial data of patients treated for nontraumatic subarachnoid hemorrhage and unruptured cerebral aneurysms. The mean hospitalization period for all patients was 19.2 days and that of patients with unruptured intracranial aneurysms was 10.9 days.

Immediate Clinical Outcome

- All 70 patients were clinically evaluated prior to hospital discharge using GOS.
- Of 62 patients without SAH, 59 patients (95.2%) were classified as GOS 5, 1 patient (1.6%) as GOS 4, 1 patient (1.6%) as GOS 3, and 1 patient (1.6%) as GOS 2.

Immediate Clinical Outcome

- Of 8 patients with SAH from ruptured paraclinoid aneurysms, 6 (75%) patients were classified as GOS 5 and 2 (25%) patients were classified as GOS 3.
- Of 6 patients with SAH classified as GOS 5
 - 1 patient presented H-H I
 - 2 patients H-H II
 - 2 patients H-H III
 - 1 patient H-H IV
- Two patients with SAH classified as GOS 3 presented H-H IV.

Follow-Up Clinical Outcome

- Follow-up clinical outcomes were obtained in 63 (90%) of 70 patients.
- Seven patients lost to follow-up presented with unruptured aneurysm and were all classified as GOS 5 at discharge.

Follow-Up Clinical Outcome

- There was no known case of recurrent or new SAH during the follow-up period varying from 4 to 54 months (mean, 14.4 months).
- The GOS was
 - 5 for 56 patients (88.9%)
 - 4 for 2 patients (3.2%)
 - 3 for 1 patient (1.6%)
 - 3 patients (4.7%) died of unrelated causes
 - 1 patient died in a delayed fashion secondary to embo complications

Clinical outcomes at discharge and on follow-up with respect to clinical status at presentation

Clinical status (Hunt-Hess grade)	No. of patients in Glasgow Outcome Scale score									
	At discharge (n=70)					On follow-up (mean, 14.4 mo) (n=63)				
	5	4	3	2	1	5	4	3	2	1
unruptured	59	1	1	1	0	50	2	0	0	3†
I	1	0	0	0	0	1	0	0	0	0
II	2	0	0	0	0	2	0	0	0	0
III	2	0	0	0	0	2	0	0	0	0
IV	1	0	2	0	0	1	0	1	0	1 ‡
Total	65	1	3	1	0	56	2	1	0	4
(%)	(92.9)	(1.4)	(4.3)	(1.4)	(0)	(88.9)	(3.2)	(1.6)	(0)	(6.3)

† 1 died of GB at postembo 12 mo, 1 died of pulmonary embolus at 3 mo, 1 died of complications of postembo poor neurologic condition at 6 mo

‡ Died of complications of poor neurologic condition stemming from initial impact of SAH at postembo 6mo

Summary

- The final follow-up angiographic outcomes (mean follow-up, 13.9 months) of 49 aneurysms in our study showed complete occlusion in 87.8% of aneurysms, near-complete occlusion in 6.1% of aneurysms, and partial occlusion in 6.1% of aneurysms.
- There was no subsequent bleeding from aneurysms after initial embolization during a mean clinical follow-up of 14.4 months.

Summary

- The final occlusion rate of aneurysms was clearly improved from primary angiographic results after retreatment.
- The primary complete occlusion rate of 72.6% had improved to 87.8% after retreatment.
- The overall immediate procedure-related morbidity and mortality were 8.3% and 0%, respectively.
- Delayed procedure related mortality rate was 1.4% (6m deaths)

Summary

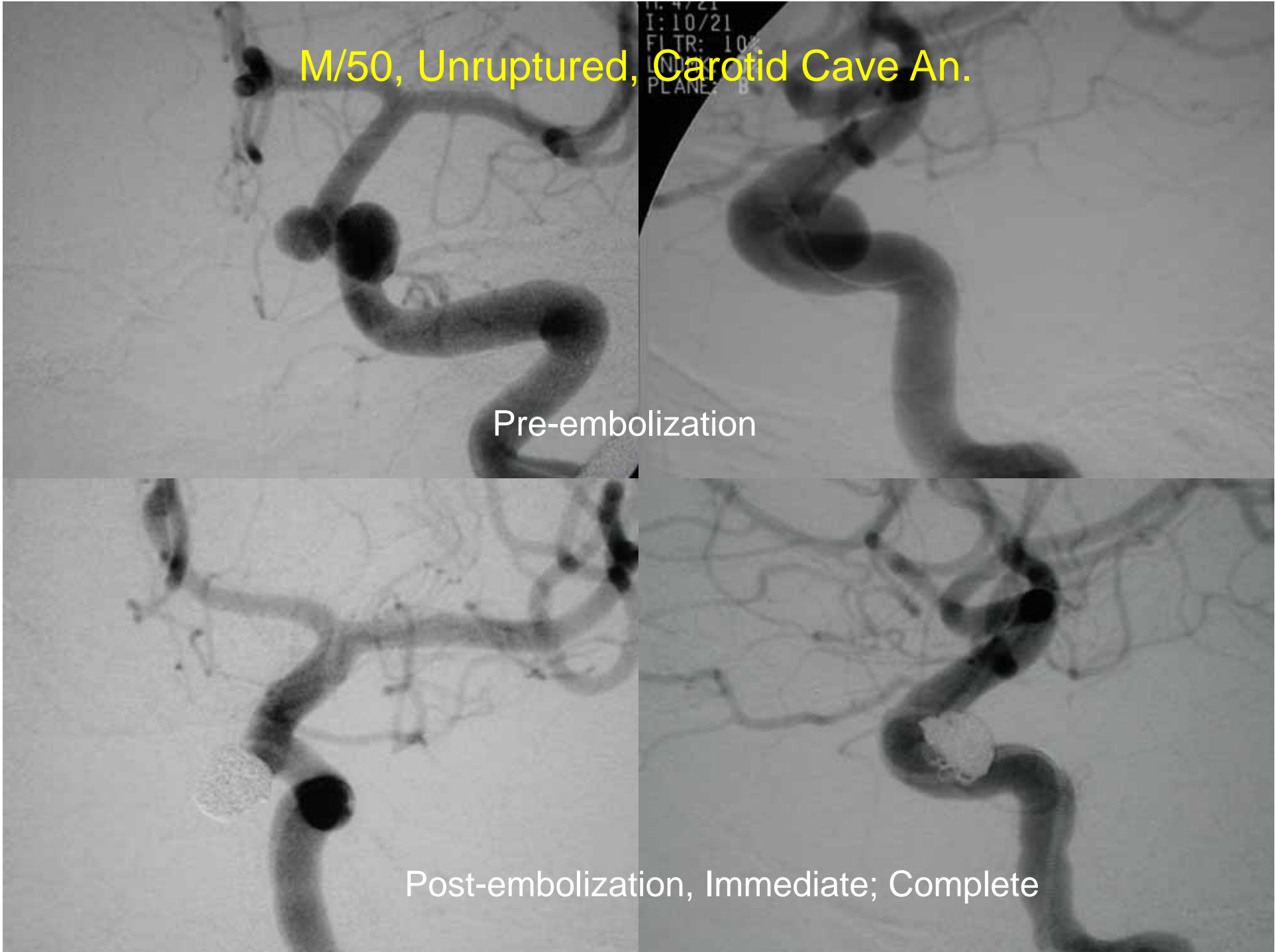
- We found no significant influence of neck size and fundus/neck ratio on occlusion rates.
- The use of remodeling technique and newly designed coils seems to have allowed for similar results to be obtained whatever the neck size or the fundus/neck ratio.
Remodeling technique was used in 16 of 84 procedures, and 3-D GDCs or Micrus spherical coils were liberally employed.

M/50, Unruptured, Carotid Cave An.

Pre-embolization

Post-embolization, Immediate; Complete

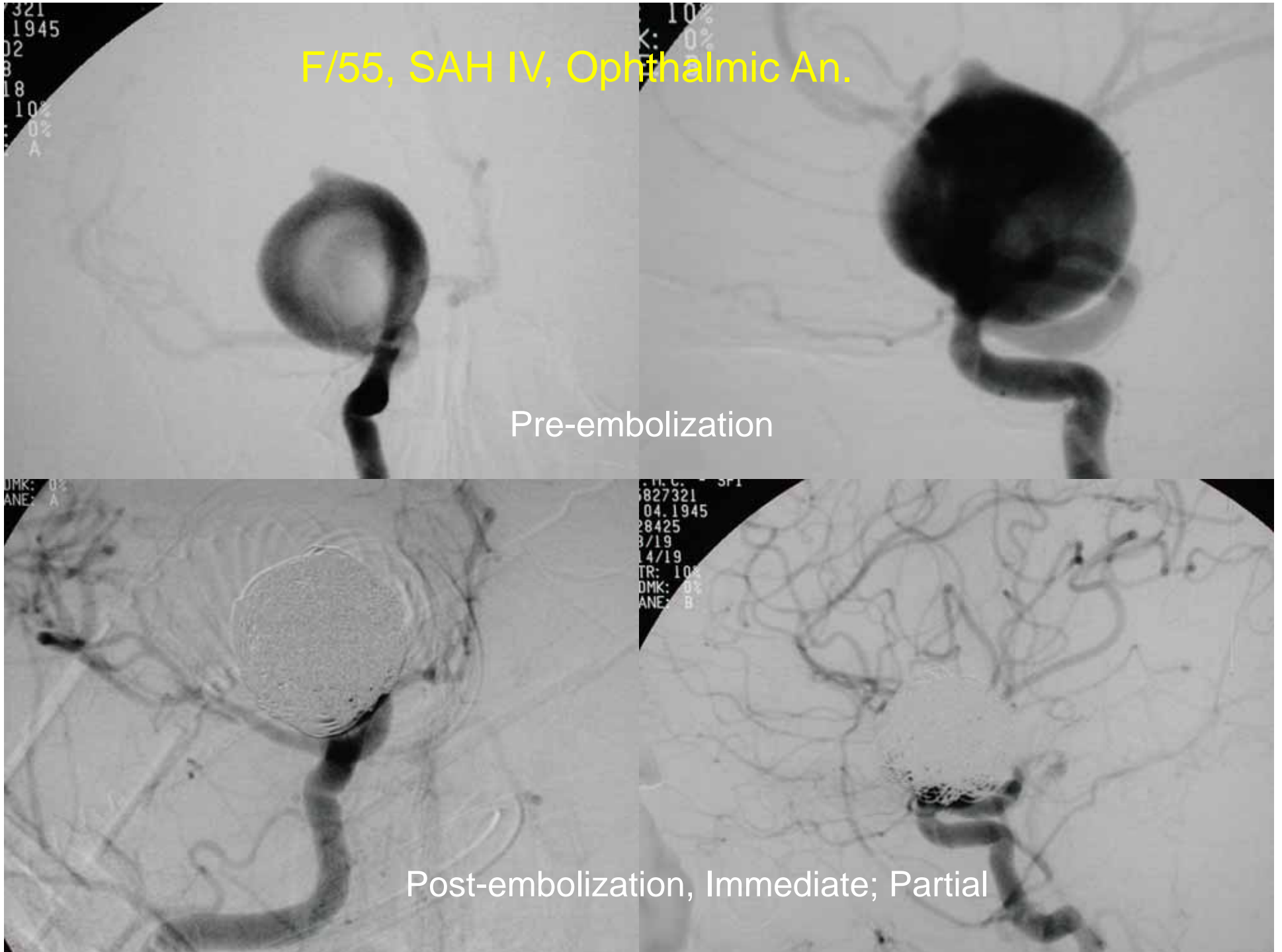
P: 47/21
I: 10/21
FLTR: 10%
UNIP:
PLANE: 8

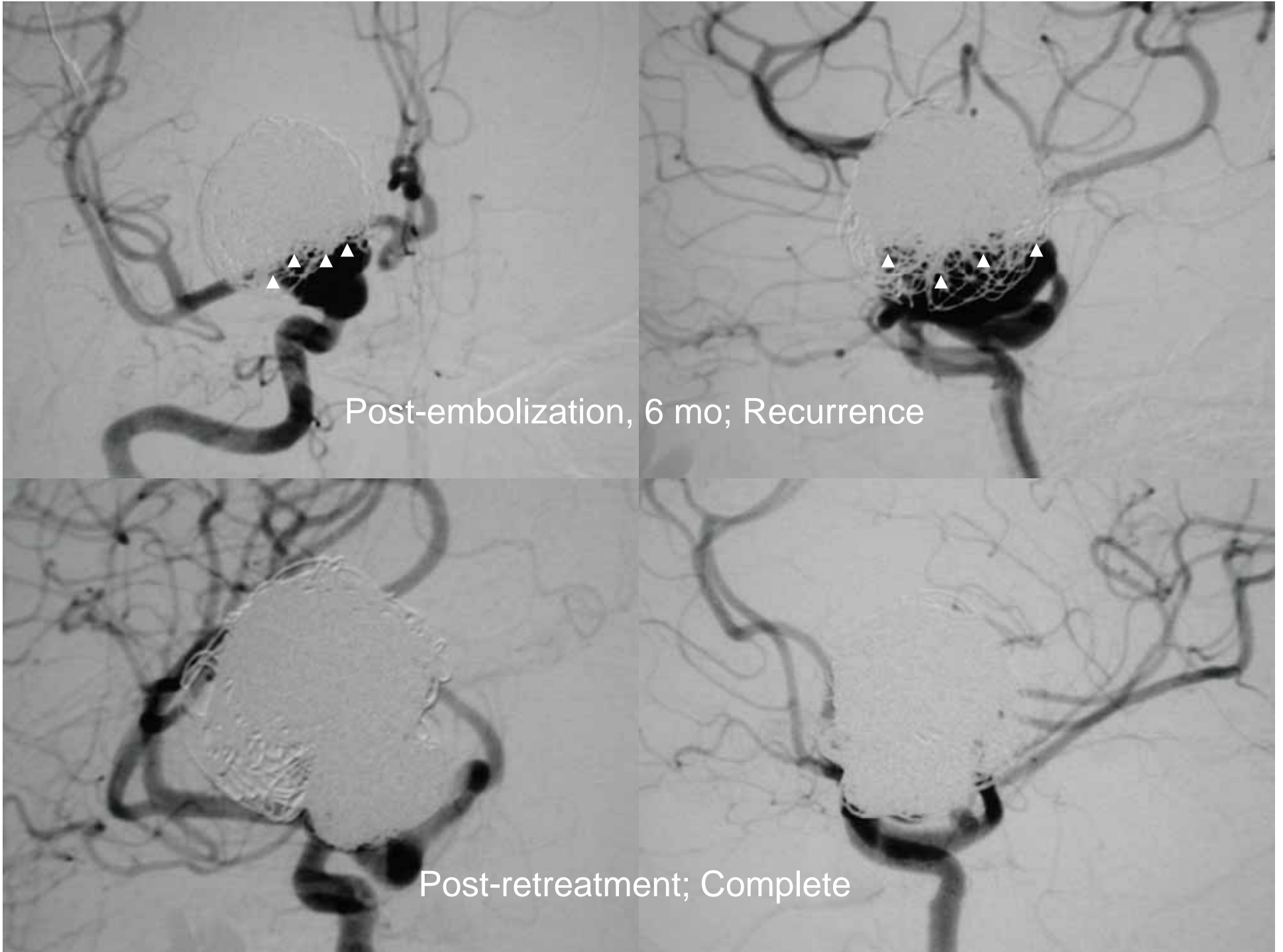


F/55, SAH IV, Ophthalmic An.

Pre-embolization

Post-embolization, Immediate; Partial





Post-embolization, 6 mo; Recurrence

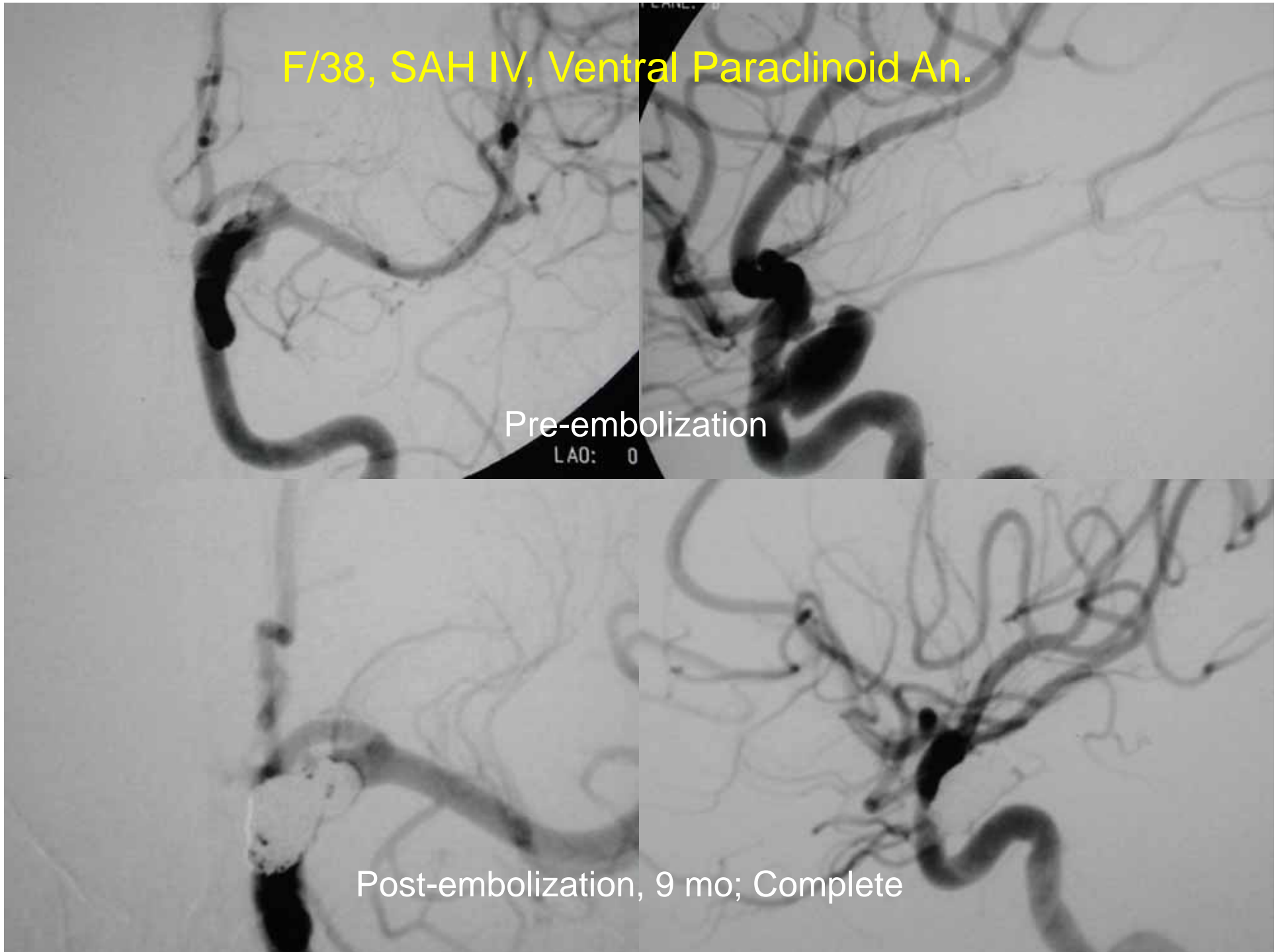
Post-retreatment; Complete

F/38, SAH IV, Ventral Paraclinoid An.

Pre-embolization

LAO: 0

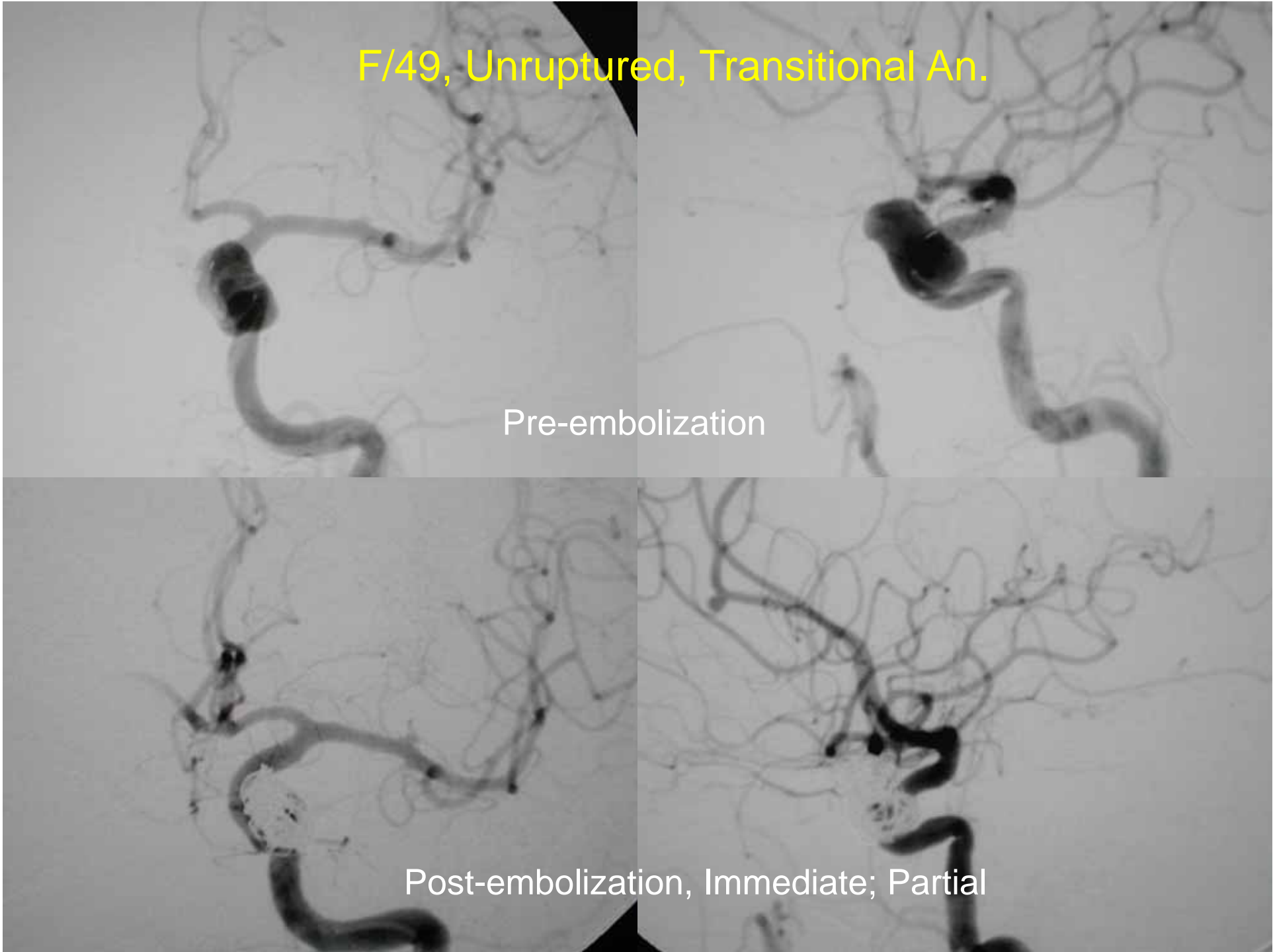
Post-embolization, 9 mo; Complete



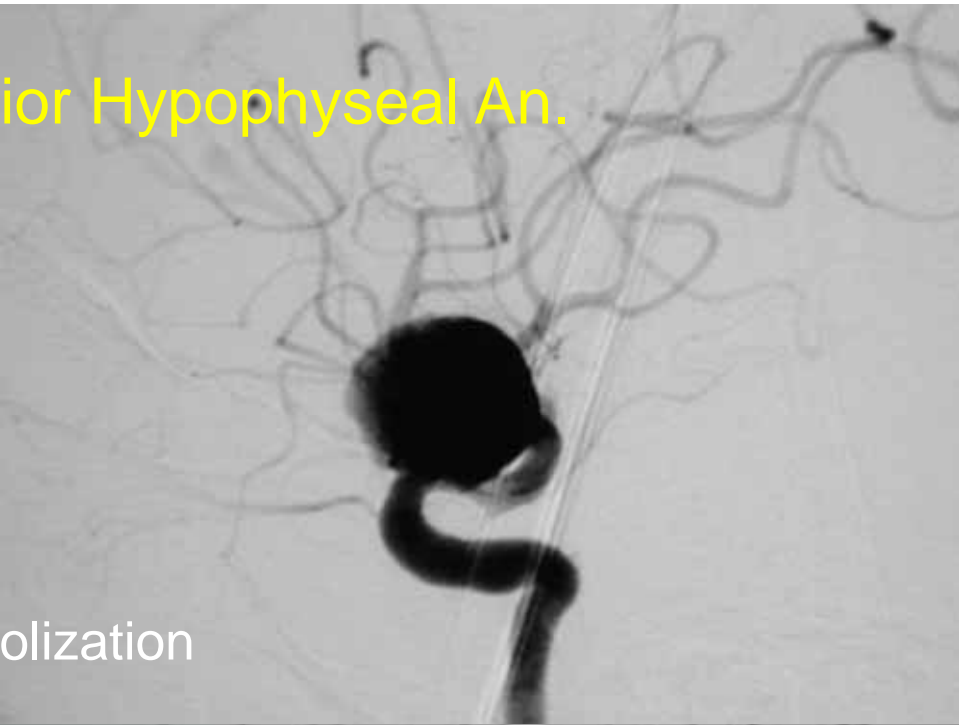
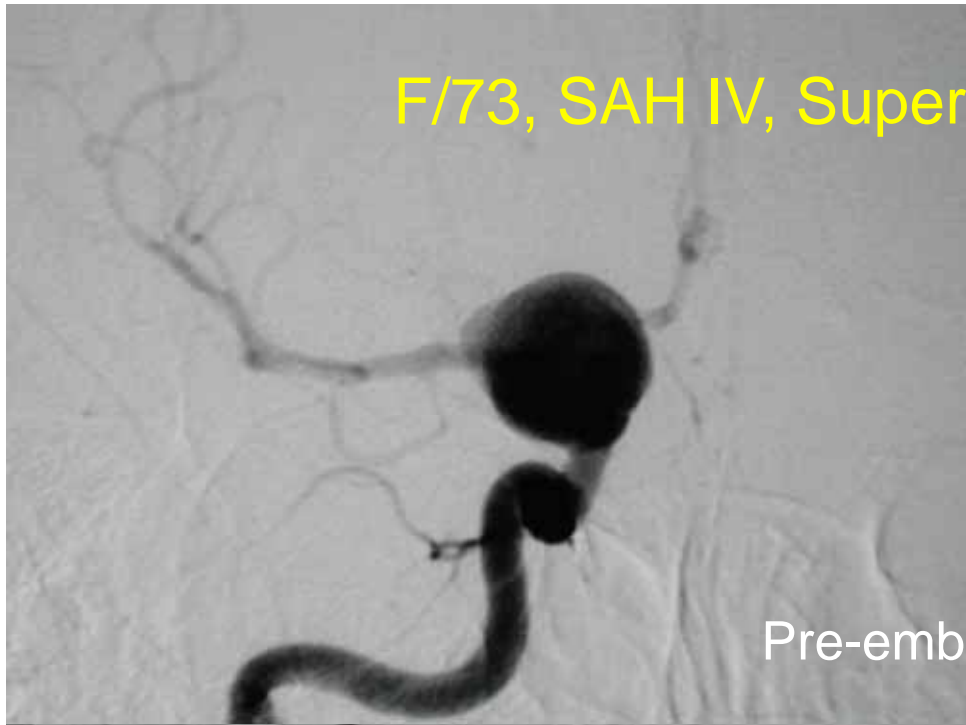
F/49, Unruptured, Transitional An.

Pre-embolization

Post-embolization, Immediate; Partial



F/73, SAH IV, Superior Hypophyseal An.



Pre-embolization



Post-embolization, Immediate; Partial

UPMC/UTSW Aneurysm Results by Location

	A comm	Paraclinoid
Years	1993-2001	1993-2002
Number pts	N=65	N=70
Angio post coil	N=65	N=70
C	72%	72.6%
P	23%	8.2%
I	5%	19.2%
Angio FU	N=32 (10m)	N=49 (14m)
C	78%	87.8%
P	16%	6.1%
I	6%	6.1%
Bleed/Rebleed	3%	0%
Neuro morb	7.5%	8.3%
Neuro mort	4.5%	0% (1.4%)